Dart Aerospace Ltd.

Date: Friday, 18/04/2008 1:17:47 PM
User: Jean-Luc Menard

Process Sheet

Customer	: CU-DAR001 Dart Helicopters Services	Drawing Name	: OUTER AFT SADDLE
Job Number	: 38690		
Estimate Number	: 11080		
P.O. Number	:	Part Number	: D5955
This Issue	: 18/04/2008 S.O. No. :	Drawing Number	: D5955 REV B
Prsht Rev.	: NC	Project Number	: N/A
First Issue	: / / Type : MACHINED PARTS	Drawing Revision	: B
Previous Run	: 38367	Material	:
Written By	: 08.04.18	Due Date	: 25/04/2008 Qty: ~~7~~ 6 Um: Each
Checked & Approved By	:		
Comment	: Est Rev:E Re-Format 05-11-29 JLM		
	Est Rev:F ecn826 06.12.06 ec		

Additional Product

Job Number:

Seq. #:	Machine Or Operation:	Description :
1.0	D6101013	Saddle Billet

Comment: Qty.: 1.0000 Each(s)/Unit Total : 7.0000 Each(s)
D6101-013 (7075-T7351)
Size 2.50" x 10.10" X 8.25" (Grain along 10.10") (D6101013 Not in system)
Batch: B 23798 x 3
B 21800 x 3
SF 08/04/21

Seq. #:	Machine Or Operation:	Description :
2.0	HAAS3	HAAS CNC VERTICAL MACHINING #3

P10 Last Page

Comment: HAAS CNC VERTICAL MACHINING #3

1-Machine as per folio D5955,Ensure Batch Number is entered

2-Machine Keyway

3-Deburr & Tumble DJP / SF 08/04/21

Seq. #:	Machine Or Operation:	Description :
3.0	QC1	INSPECT ALL DIM TO DIM SHEET

Comment: INSPECT ALL DIM TO DIM SHEET DJP 08/04/22

Seq. #:	Machine Or Operation:	Description :
4.0	QC8	SECOND CHECK

Comment: SECOND CHECK 08.04.22 6

Seq. #:	Machine Or Operation:	Description :
5.0	HAND FINISHING1	HAND FINISHING RESOURCE #1

Comment: HAND FINISHING RESOURCE #1
Chemical Conversion Coat as per QSI 005 4.1 FD 08/04/24 6

Form: rprocess

Date: Friday, 18/04/2008 1:17:47 PM
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Process Sheet

Customer: CU-DAR001 Dart Helicopters Services
Drawing Name: OUTER AFT SADDLE

Job Number: 38690
Part Number: D5955

Job Number:

Seq. #:	Machine Or Operation:	Description :
6.0	POWDER COATING	POWDER COATING

M107550

Comment: POWDER COATING
Powder Coat White Gloss (Ref: 4.3.5.1) as per QSI 005 4.3   91 08-04-25

Seq. #:	Machine Or Operation:	Description :
7.0	QC3	INSPECT POWDER COAT/CHEMICAL CONVERSION

Comment: INSPECT POWDER COAT/CHEMICAL CONVERSION   AS BL 08-04-25   6

Seq. #:	Machine Or Operation:	Description :
8.0	PACKAGING 1	PACKAGING RESOURCE #1

Comment: PACKAGING RESOURCE #1
Identify and Stock
Location: ST421   AS 08/04/25   X6

Seq. #:	Machine Or Operation:	Description :
9.0	QC21	FINAL INSPECTION/W/O RELEASE

08/04/28

Comment: FINAL INSPECTION/W/O RELEASE

Job Completion   JMF 08-04-25

138690
D5955
25/04/2008
S.118 08.41
#1 322.2 F
#2 30min F
#3 ---- F
#4 ---- F

Form: rprocess

DART AEROSPACE LTD	Work Order:	38690
Description: Outer Aft Saddle	Part Number:	D5955
Inspection Dwg: D5955 Rev: B		Page 1 of 1

Inspect dimensions highlighted on inspection sheet drawing and record below:

Dim	Min	Max	Go/No Go Gauge	Recorded Actual Dimensions 1	2	3	4	By	Date
A	0.438	0.443		.443	0.443	0.443	0.443		
B	1.745	1.755		1.750	1.750	1.750	1.750		
C	5.245	5.255		5.250	5.250	5.250	5.250		
D	6.995	7.005		7.000	7.000	7.000	7.000		
E	~~5.745~~ 5.240	~~5.755~~ 5.260		5.250	5.250	5.250	5.250		
F	4.745	4.755		4.750	4.750	4.750	4.750		
G	0.315	0.322		.319	.319	.319	.319		
H	1.522	1.532		1.528	1.528	1.526	1.526		
I	3.048	3.058		3.052	3.051	3.050	3.050		
J	4.575	4.585		4.581	4.580	4.581	4.581		
K	0.313	0.318		.318	.318	.318	.318		
L	0.495	0.505		.501	.501	.501	.501		
M	0.490	0.510		.505	.503	.502	.502		
N	1.865	1.885		1.885	1.858	1.854	1.854		
O	7.990	8.010		7.999	8.003	8.004	7.999		
P	2.240	2.260		2.250	2.224	2.224	2.224		
Q	0.307	0.312		.310	0.310	0.309	0.309		
R	0.760	0.765		.760	0.760	0.760	0.760		
S	0.490	0.510		.502	0.509	0.503	0.507		
T	1.625	1.645		1.631	1.631	1.631	1.629		
U	2.000	2.020		2.003	2.003	2.004	2.000		
V	0.023	0.043		.033	0.033	0.033	0.033		
W									
X									
Y									
Z									
AA									
AB									
AC									
AD									
AE									
AF									
AG									
AH									
Accept/Reject									

Measured by:	SD	Audited by	TG
Date:	08/04/21	Date:	08.04.22

Rev	Date	Change	Revised by	Approved
A	99.04.19	New Issue	RF	
B	02.12.13	Reformat; Added Dim. T-U & DT8682, DT8686	KJ/RF	
C	06.11.20	Added dimension V	KJ/JLM	
D	06.12.06	Dimensions L,N,P revised	KJ/EC	
E	07.06.15	Dimension G revised	KJ/JLM	

DART AEROSPACE LTD	Work Order:	38690
Description: Outer Aft Saddle	Part Number:	D5955
Inspection Dwg: D5955 Rev: B		Page 1 of 1

Inspect dimensions highlighted on inspection sheet drawing and record below:

5.240 ↓ 5.260

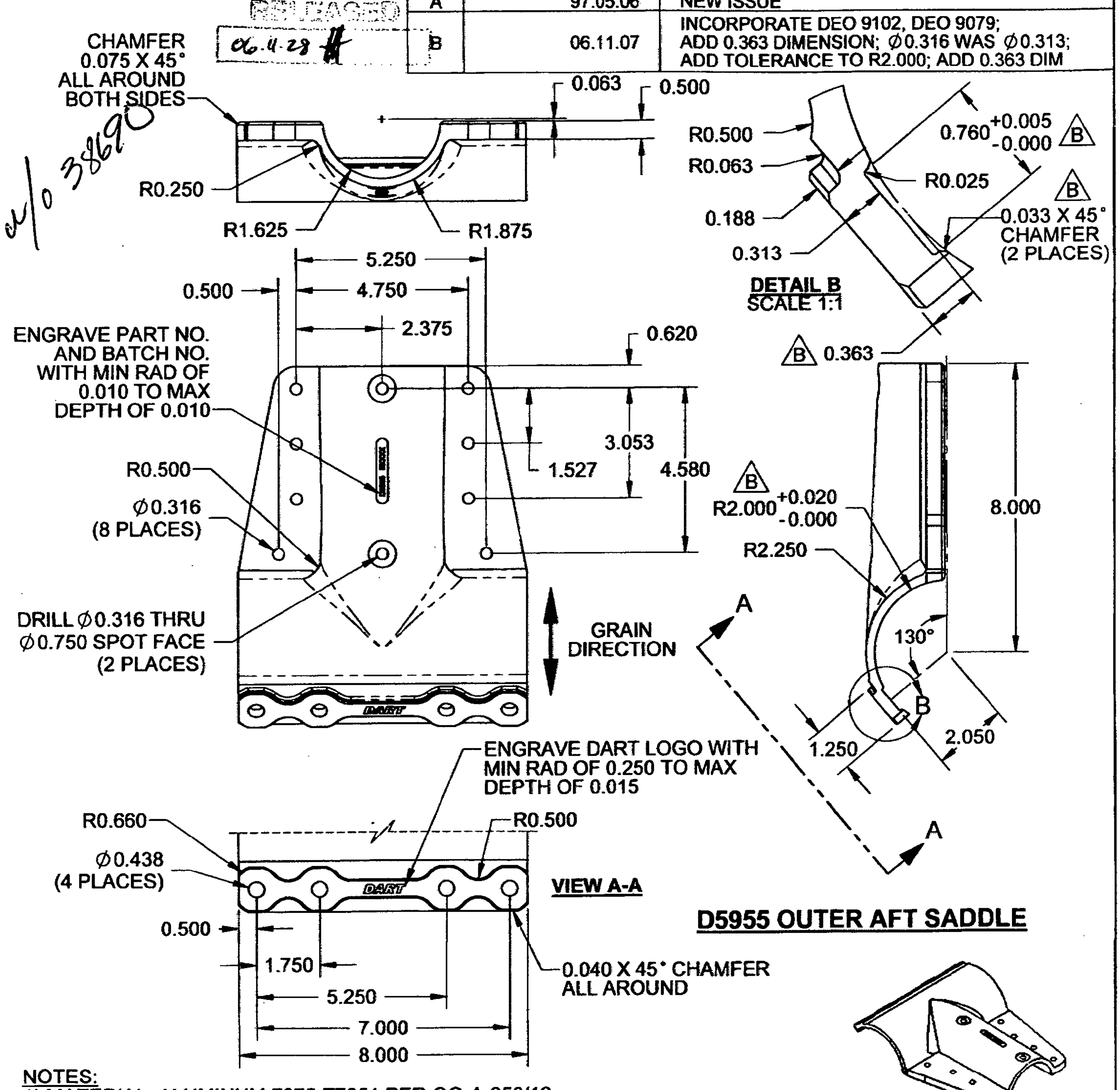
				Recorded Actual Dimensions					
Dim	Min	Max	Go/No Go Gauge	5	6	3	4	By	Date
A	0.438	0.443		0.443	0.443				
B	1.745	1.755		1.750	1.750				
C	5.245	5.255		5.250	5.250				
D	6.995	7.005		7.000	7.000				
E	~~5.745~~	~~5.755~~		5.250	5.250				
F	4.745	4.755		4.750	4.750				
G	0.315	0.322		.319	.319				
H	1.522	1.532		1.526	1.526				
I	3.048	3.058		3.051	3.051				
J	4.575	4.585		4.581	4.581				
K	0.313	0.318		.318	.318				
L	0.495	0.505		.501	.501				
M	0.490	0.510		.503	.503				
N	1.865	1.885		1.854	1.855				
O	7.990	8.010		7.999	7.999				
P	2.240	2.260		2.224	2.227				
Q	0.307	0.312		0.311	0.311				
R	0.760	0.765		0.760	0.760				
S	0.490	0.510		0.507	0.509				
T	1.625	1.645		1.629	1.630				
U	2.000	2.020		2,000	2.002				
V	0.023	0.043							
W									
X									
Y									
Z									
AA									
AB									
AC									
AD									
AE									
AF									
AG									
AH									
Accept/Reject									

Measured by:	SP	Audited by	08.04.22
Date:	08/04/21	Date:	

Rev	Date	Change	Revised by	Approved
A	99.04.19	New Issue	RF	
B	02.12.13	Reformat; Added Dim. T-U & DT8682, DT8686	KJ/RF	
C	06.11.20	Added dimension V	KJ/JLM	
D	06.12.06	Dimensions L,N,P revised	KJ/EC	
E	07.06.15	Dimension G revised	KJ/JLM	

DESIGN	DRAWN BY	DART AEROSPACE LTD
BW	CB	HAWKESBURY, ONTARIO, CANADA
CHECKED: LE	APPROVED	DRAWING NO. D5955 — REV. B — SHEET 1 OF 1
DATE: 06.11.07		TITLE: OUTER AFT SADDLE — SCALE 1:4

REV	DATE	DESCRIPTION
A	97.05.06	NEW ISSUE
B	06.11.07	INCORPORATE DEO 9102, DEO 9079; ADD 0.363 DIMENSION; ∅0.316 WAS ∅0.313; ADD TOLERANCE TO R2.000; ADD 0.363 DIM



ISOMETRIC VIEW
SCALE 1:8

NOTES:
1) MATERIAL: ALUMINUM 7075-T7351 PER QQ-A-250/12
(MAKE FROM D6101-013 SADDLE BILLET, 7075)
2) FINISH: CHEMICAL CONVERSION COAT PER DART QSI 005 4.1
POWDER COAT GLOSS WHITE (4.3.5.1) PER DART QSI 005 4.3 B
3) TOLERANCES ARE PER DART QSI 018 UNLESS OTHERWISE NOTED
4) ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED
5) BREAK ALL SHARP EDGES 0.010 TO 0.020

Dart Aerospace Ltd

W/O:		WORK ORDER CHANGES					
DATE	STEP	PROCEDURE CHANGE	By	Date	Qty	Approval Chief Eng / Prod Mgr	Approval QC Inspector

Part No: D5955 D205-594 PAR #: N/A Fault Category: Prod/Machined Parts NCR: (Yes) No DQA: D Date: 08/04/22

QA: N/C Closed: D Date: 08/04/22

NCR: 38690		WORK ORDER NON-CONFORMANCE (NCR)						
DATE	STEP	Description of NC Section A	Corrective Action Section B			Verification Section C	Approval Chief Eng	Approval QC Inspector
			Initial Chief Eng	Action Description Chief Eng	Sign & Date			
08/04/22	~~1~~ 2.1	During Routine check by machinist it was found the Dim. 1.875" ("N" outside Bore for X-tube) is actually 1.85~~5~~." Also 2.250" Bore ("P" ~~Bo~~ outside Bore for skid tube) is 2.224".	08.04.22 QSI 042	Remove the ~~Bot~~ offset on Ball mill. PARTS ACCEPTABLE. MARGINS STILL POSITIVE. REF ATTACHED SHEET.	Sig for SR. 08/04/22 DJP 08/04/22	08/04/22	08.04.22 QSI 042	08/04/22
		R.C found that A tool ~~ore~~ A offset on Ball mill. 5 Parts Affected.			DJP 08/04/22	08/04/22		08/04/22
		Machinist is Seb. Fournier						

NOTE: Date & initial all entries

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Rev. B
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5.0 Saddle Attachment Analysis

5.1 Saddle Attachment Geometry

Figure 1 in Reference 1 illustrates the geometry and co-ordinate system of the saddles and skidtube.

$Lsad := 8 \cdot in$		Saddle length
$tover := 0.250 \cdot in$		Saddle overhang thickness
$Df := 0.438 \cdot in$		Saddle flange bolt holes, diameter
$tf := 0.313 \cdot in$		Saddle flange thickness
$wf := 0.75 \cdot in$		Skidtube flange thickness
$ef := 0.281 \cdot in$		Saddle flange edge distance
$Dx := 0.313 \cdot in$		Saddle-to-crosstube bolt holes, diameter
$ex := 0.464 \cdot in$		Saddle edge distance near saddle-to-crosstube bolt holes
$tr := 0.220 \cdot in$	WAS 0.250	Saddle thickness at saddle-to-crosstube interface
$tmat := 0.500 \cdot in$		Saddle thickness at AN5 attachment flanges
$ctube := 1.375 \cdot in$		Crosstube radius at cuff (portion in saddle)
$hf := 6 \cdot in$		Crosstube bore height (portion in saddle)
$tc := 0.375 \cdot in$		Thickness of crosstube wall
$cy := 2.00 \cdot in$		Skidtube, vertical radius
$cz := 2.05 \cdot in$		Skidtube, horizontal radius
$wall := 0.100 \cdot in$		Skidtube wall thickness
$ts := cz - cy + wall$	$ts = 0.15 \cdot in$	Skidtube minimum wall thickness at the location ridge
$nt := 8$		Number of skidtube bolt shear areas
$ns := 4$		Number of saddle quadrants
$nc := 4$		Number of crosstube bolt shear areas
$nf := 4$		Number of flange bolts each side of crosstube

5.2 Maximum Forces and Moments

In comparing the D5951/D5953/D5955/D5957 saddles used in D205-594-011 vs the D2571/D2572/D2573/D2574 saddles used in D205-634-011 (existing high gear skidtube approved per TC STC SH96-88 and FAA STC SR00563NY), the D5951/D5953/D5955/D5957 saddles have been significantly reinforced for the larger overturning moments. Because the D205-594-011 landing gear is softer than existing high-gears (such as the Dart D212-664-101/-201 crosstubes approved per TC STC SH01-9 and FAA STC SR01298NY), all other saddle loads generated by crosstube stiffness are less than for existing high-gear crosstubes (as verified by deflection testing per TP-D205-594-2). Therefore, this analysis determines whether the D5951/D5953/D5955/D5957 saddles are capable of sustaining the larger overturning moment created by FAR 29.501(c) and FAR 29.501(f1). To be conservative, the moment arms used in these calculations correspond to the undeflected heights of the crosstubes.

$Mf := (0.223 \cdot 2.92 \cdot 1722 \cdot lb) \cdot (42.00 \cdot in)$	$Mf = 47094 \cdot lb \cdot in$	FAR 29.501(c) @ Forward Saddle
$Ma := (0.223 \cdot 2.37 \cdot 3915 \cdot lb) \cdot (40.00 \cdot in)$	$Ma = 82765 \cdot lb \cdot in$	FAR 29.501(c) @ Aft Saddle

$GW := 11200 \cdot lb$ Gross weight of 212, which is most critical in Bell 204/205/212 series

$Fzsad := \frac{1}{2} \cdot 1.33 \cdot GW \cdot \cos(45 \cdot deg)$	$Fzsad = 5267 \cdot lb$	FAR 29.501(f1) Vertical Load
$Fxsad := \frac{1}{2} \cdot 1.33 \cdot GW \cdot \sin(45 \cdot deg)$	$Fxsad = 5267 \cdot lb$	FAR 29.501(f1) Fwd Load
$Mysad := Fxsad \cdot 42.00 \cdot in - Fzsad \cdot 4 \cdot in$	$Mysad = 200128 \cdot lb \cdot in$	FAR 29.501(f1) @ Fwd Saddle **Most Critical**

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Crosstube fastener analysis

This calculation checks for strength of the bolts that hold the saddle onto the crosstubes and the surrounding saddle material. The shear force is calculated as the resultant of Fxsad and Fzsad.

$P := \dfrac{\sqrt{Fxsad^2 + Fzsad^2}}{nc}$ $P = 1862 \cdot lb$ Resultant shear force

a) Bolt Strength

$MS3a := \dfrac{FsuAN5}{P} - 1$ $MS3a = 2.09$ **Margin of Safety**

b) Bearing Stress on Saddle Near Saddle-to-Crosstube Fasteners

$Ab := Dx \cdot tr$ $Ab = 0.07 \cdot in^2$ Bearing area near crosstube fasteners

$\sigma b := \dfrac{P}{Ab}$ $\sigma b = 27040 \cdot lb \cdot in^{-2}$ Bearing stress

$MS3b := \dfrac{Fbry3}{\sigma b} - 1$ $MS3b = 2.44$ WAS 2.91 **Margin of Safety**

c) Shear Tear-out in Saddle-to-Crosstube Bolt Area

$As := 2 \cdot ex \cdot tr$ $As = 0.2 \cdot in^2$ Shear area near crosstube fasteners

$\sigma s := \dfrac{P}{As}$ $\sigma s = 9120 \cdot lb \cdot in^{-2}$ Shear stress

$MS3c := \dfrac{Fsu3}{\sigma s} - 1$ $MS3c = 3.39$ WAS 3.89 **Margin of Safety**

d) Bearing Stress on Crosstube Near Saddle-to-Crosstube Fasteners

$Ab := Dx \cdot tc$ $Ab = 0.12 \cdot in^2$ Bearing area near crosstube fasteners

$\sigma b := \dfrac{P}{Ab}$ $\sigma b = 15864 \cdot lb \cdot in^{-2}$ Bearing stress

$MS3d := \dfrac{Fbry1}{\sigma b} - 1$ $MS3d = 4.80$ **Margin of Safety**

Saddle Splitting Force

The bending moment Mysad has a tendancy to try to split the two pieces of saddle apart, thereby placing the flange bolts in tension. Figure 3 of Reference 1 illustrates a conservative method for calculating this splitting force.

$Fs := 0.31 \cdot \dfrac{Mysad}{nf \cdot hf}$ $Fs = 2584.99 \cdot lb$ Saddle splitting force per flange fastener

$MS4 := \dfrac{FtyAN5}{Fs} - 1$ $MS4 = 0.93$ **Margin of Safety**

Saddle Material Strength

This calculation checks the strength of the saddle material through the critical cross section illustrated in Figure 4 of Reference 1. The estimates for the inertia values and the area of this cross section are also shown in the Reference section.

$Lf := \frac{Lsad}{2} - ctube$	$Lf = 2.63 \cdot in$	Flange length
$CGx := ctube + 0.5 \cdot Lf$	$CGx = 2.69 \cdot in$	Center of Gravity of flange
$Ix := \frac{\pi}{4} \cdot \left[(ctube + tr)^4 - ctube^4 \right] + 4 \cdot \left(\frac{1}{12} \cdot tmat \cdot Lf^3 + tmat \cdot Lf \cdot CGx^2 \right)$		$Ix = 43.21 \cdot in^4$
$A := \pi \cdot \left[(ctube + tr)^2 - ctube^2 \right] + 4 \cdot tmat \cdot Lf$		$A = 7.3 \cdot in^2$

a) Stress due to Mysad and Fzsad

$\sigma z := \frac{Mysad \cdot Lsad}{2 \cdot Ix} + \frac{Fzsad}{A}$	$\sigma z = 19247.55 \cdot lb \cdot in^{-2}$	Stress due to Mysad and Fzsad
$MS5a := \frac{Fcy3}{\sigma z} - 1$	$MS5a = 1.81$ WAS 1.83	**Margin of Safety**

b) Shear Stress due to Fxsad

$\tau xy := \frac{Fxsad}{A}$	$\tau xy = 721.17 \cdot lb \cdot in^{-2}$	Shear stress
$MS5b := \frac{Fsu3}{\tau xy} - 1$	$MS5b = 54.47$ WAS 56.77	**Margin of Safety**

5.4 Margin of Safety Summary

$MS1a = 0.99$ Shear strength of saddle ridge, ultimate
$MS1b = 2.49$ Shear strength of saddle ridge, yield

$MS2a = 12.09$ Saddle-to-skidtube bolt strength
$MS2b = 18.37$ Saddle-to-skidtube bearing on saddle
$MS2c = 9.69$ Saddle-to-skidtube shear tear-out
$MS2d = 7.18$ Saddle-to-skidtube bearing on skidtube

$MS3a = 2.09$ Saddle-to-crosstube bolt strength
$MS3b = 2.44$ Saddle-to-crosstube bearing on saddle
$MS3c = 3.39$ Saddle-to-crosstube shear tear-out
$MS3d = 4.80$ Saddle-to-crosstube bearing on crosstube

$MS4 = 0.93$ Saddle splitting

$MS5a = 1.81$ Saddle stress due to Myrot and Fzrot
$MS5b = 54.47$ Saddle shear stress

9/08.04.22

MARGINS ARE STILL POSITIVE

6.0 Conclusion

All margins are positive, therefore the saddle attachment for the D205-594-011 Extended Height Landing Gear meet the loading requirements of FAR 29.471/473/501/571. The drop weight for TP-D205-594-1 will be increased to 6320 lb, to account for the damage tolerance of ICA-D205-594 and the requirements of FAR 29.501(d2). The fatigue life of the crosstubes is sufficiently long to allow for an "on condition" replacement criteria in ICA-D205-594.